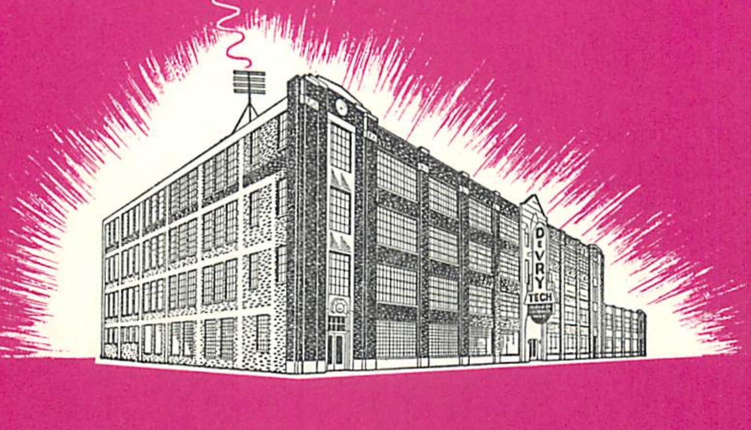
MONITORS and ACCESSORY EQUIPMENT

Lesson T4E-5A



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MONITORS AND ACCESSORY EQUIPMENT

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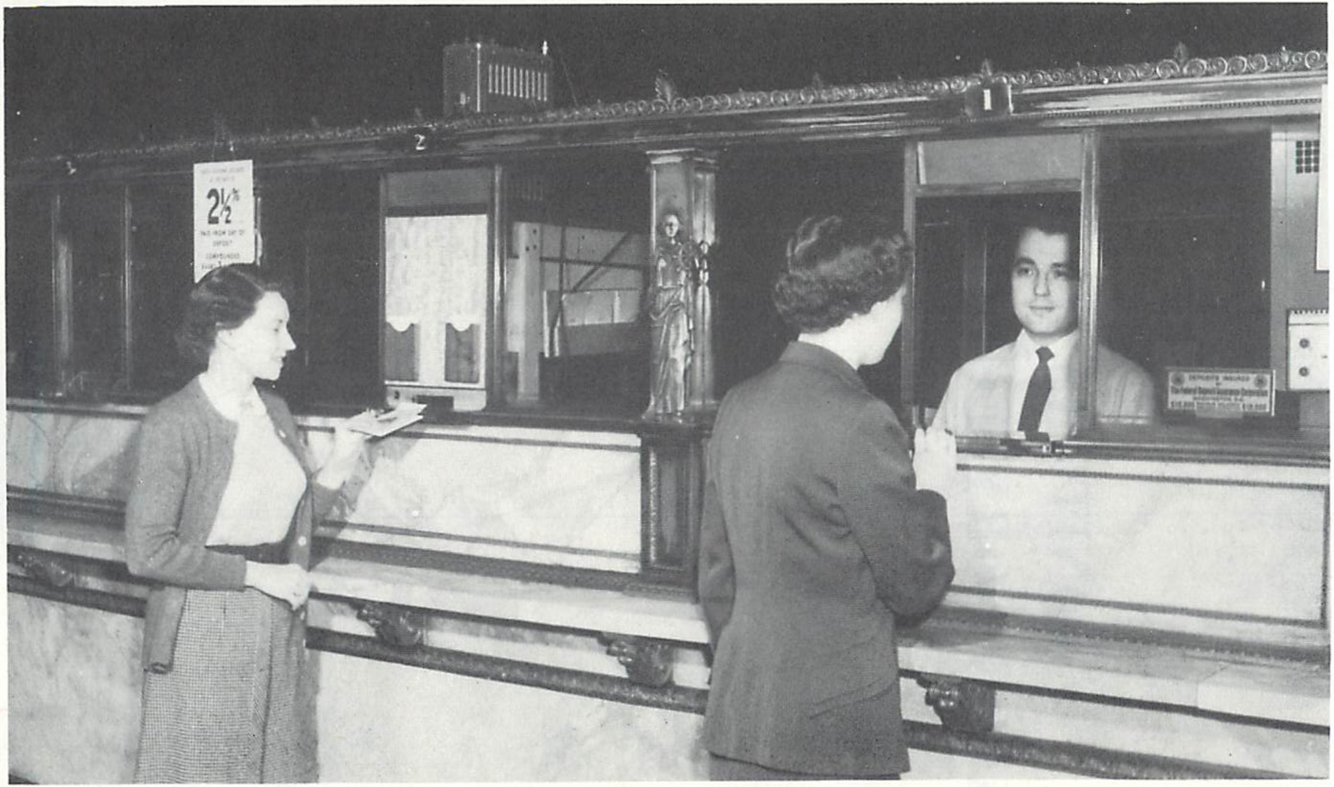

Closed circuit TV system being used in a bank. The lady at the left is inserting a deposit slip into an opening which permits the camera, mounted directly above the enclosure, to "see" and transmit the data to a remote monitor.

Courtesy Allen B. DuMont Laboratories, Inc.

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Success doesn't happen. It is organized, pre-empted, captured by concentrated common sense.

—Frances E. Willard

MONITORS AND ACCESSORY EQUIPMENT

In previous lessons, all of the equipment necessary to produce the video signal has been explained. Now there remains only the equipment which is necessary to reproduce the picture. This equipment includes a monitor or television receiver, a distribution system to feed the reproducing units and the accessory equipment which is often used with the entire camera chain such as lenses, regulated power supplies and interconnecting cables.

MONITORS

Probably the most common reproducing unit used in closed circuit TV systems is the **monitor.** A comparison of the block diagram of Figure 1 with the block diagram of a conventional TV receiver reveals that the circuits following the video second detector in the TV receiver are almost identical to the complete monitor circuits. The major exception is the complete lack of a sound system in the monitor, and provisions for injecting external sync.

Circuit Description

To analyze the circuits of the monitor, the schematic diagram of a typical unit is shown in Figure 2. This particular monitor is manufactured by the Dage Television Company to be used in conjunction with their camera chain. However, it can also be used with equipment made by other manufacturers.

Starting at video amplifier V_1, notice that there are two video input jacks connected in parallel. The purpose of this arrangement is twofold. Since the monitors in an industrial set-up are practically always a considerable distance away from the camera or the camera control unit, a coaxial cable is used to feed the various signals from either of these units to the monitor. In order to prevent serious distortion of the signal, the coaxial cable must be terminated with a resistance that is equal to its characteristic impedance. If only one monitor is being used, the coaxial cable is connected to one video input jack and a dummy coaxial connector with a built in load resistor is connected to the other jack.

When more than one monitor is being used, the coaxial cable is fed from the camera control unit to one video input jack of the first monitor and another coaxial cable is connected from the remaining video input jack to one of the video input jacks of the second monitor. The coaxial connector with the built in load resistor is then connected to the remaining input jack. In this way the coaxial cable is always terminated at its far end. Examples of this distribution system will be shown later in the lesson.

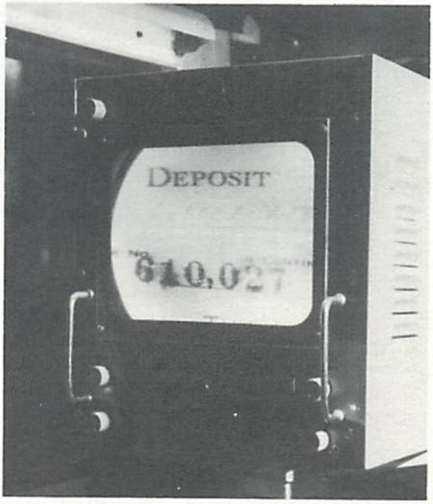
The first video amplifier is a conventional stage employing L_1 and L_2 as peaking coils. These coils, along with R_5, R_{26} and the components in the plate and cathode circuit of V_2 are selected to give the desired overall frequency response. When the smaller values of components are used (selections are listed in the table of values in the upper right hand corner of the diagram), the overall frequency response is about 8 megacycles. When the larger values are used, a reduction in frequency response and a corresponding increase in gain is obtained.

The contrast control varies the gain of the first video amplifier by varying the amount of bias on the 6CB6 tube. The input signal must be such that the blanking pulses are negative in polarity so the signal will be fed to the grid of the kinescope with the proper phase.

The cathode and grid of V_{4B} function as a diode d-c restorer while the plate-cathode section of this same tube helps to eliminate the video information from the sync pulses that are then fed to one terminal of sync selector switch S_2.

Since it is not necessary to have the sync pulses mixed with the video and blanking pulses, two sync input jacks are provided to feed external sync pulses to the monitor. The reasons for having two jacks are the same as for having two video input jacks—that of proper impedance matching.

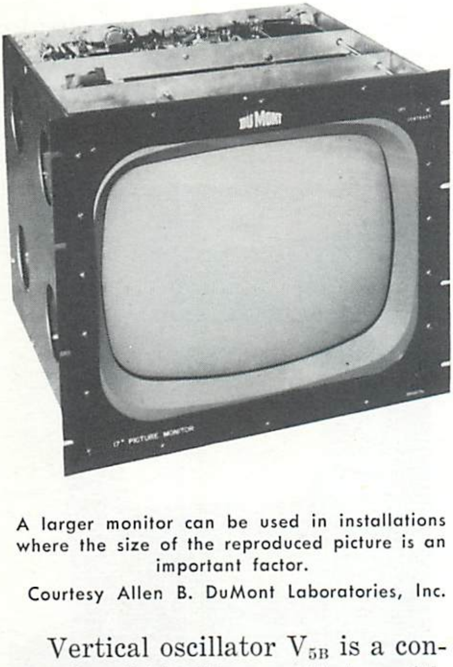
Negative sync pulses are fed to the cathode of V_{5A} which causes amplified negative pulses to appear in the plate circuit. No phase inversion occurs when the signal is fed to the cathode. These negative pulses are available at the upper left terminal of the sync selector switch. The common terminal of the sync selector switch



A monitor reproduces the data transmitted by the camera at a convenient location where files are kept.

Courtesy Allen B. DuMont Laboratories, Inc.

then feeds the desired sync signals to the grid of V_{4A}. Amplified positive pulses appear in the plate circuit of V_{4A} and are fed through the vertical integrator network (PC1) to the grid of V_{5B} where the integrated vertical pulses are used to synchronize the vertical oscillator.



A larger monitor can be used in installations where the size of the reproduced picture is an important factor.

Courtesy Allen B. DuMont Laboratories, Inc.

Vertical oscillator V_{5B} is a conventional blocking oscillator with its frequency being determined primarily by the RC network consisting of C_{16}, R_{24} and R_{25}. Vertical hold control R_{25} is variable to change the time constant and thus change the free running frequency of the oscillator.

In the plate circuit, vertical size control R_{29} varies the B+ voltage applied to the plate of the oscillator and also varies the resistance through which sawtooth forming capacitor C_{17} must charge. The combined action of the sawtooth forming capacitor and series peaking resistor R_{30} causes a trapezoidal voltage to be applied to the grid of vertical output tube V_6.

Vertical linearity control R_{32} is connected in the cathode of V_6 to vary its bias and also to vary the shape of the current which passes through V_6 and the primary of the vertical output transformer. Both halves of the 12BH7 double triode are connected in parallel to provide sufficient power to the vertical windings of the deflection yoke and produce a raster of the proper height.

From the plate circuit of V_6 a positive pulse is coupled through R_{19} and C_{12} to the cathode of the kinescope. This is a vertical retrace blanking network and causes the kinescope electron beam to be cut off during the vertical retrace period.

From the plate of V_{4A}, positive sync pulses are also fed through C_{20} to the left grid of V_7 which functions as the horizontal afc tube. The right hand section is a blocking oscillator and the entire system may be known as the pulse width or syncro-guide afc system.

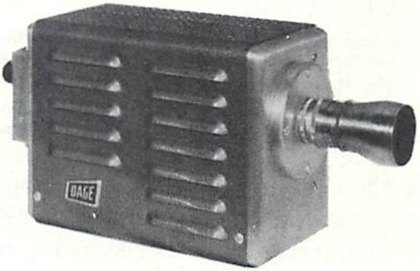
Horizontal sawtooth forming capacitor C_{29} is connected from point D of the horizontal blocking oscillator transformer to the cathode of the 6BQ6. The developed sawtooth voltage, beside being applied to the grid of the 6BQ6, is fed to an integrating network consisting of R_{51} and C_{23}. The parabolic wave-form voltage across C_{23} is then coupled, along with the sync pulses, to the grid of the afc triode. The phase relationship of these two signals determines the instantaneous conduction of the tube and the voltage developed across R_{48}. This voltage, when applied through R_{50} to the grid of the oscillator, locks the oscillator in step with the sync pulses.

Horizontal hold control R_{42} varies the B+ voltage applied to the afc tube which determines its average conduction. This, in turn, varies the average voltage across R_{48} which changes the frequency of the horizontal oscillator.

Horizontal drive control R_{44} varies the B+ available to the blocking oscillator and determines the peak-to-peak sawtooth voltage developed across C_{29}.

The remaining components in the horizontal section consist of the output transformer, damper tube, and yoke which are the conventional types found in many TV receivers. Width coil L_7 affects the impedance ratio of the primary to the secondary and will control slightly the amount of power delivered to the yoke which, in turn, determines the amount of horizontal deflection.

In the cathode of the damper tube there is developed a parabolic wave-form along with the B+ boost voltage of about 450 volts d-c. This combination is used to supply the plate of the 6BQ6. The phase of the parabolic voltage can be varied by adjusting L_8 and this voltage will add to the pulse voltage on the plate of the 6BQ6 and affect the conduction of the damper tube to help counteract any non-linearity in the sawtooth portion of the plate wave-form.

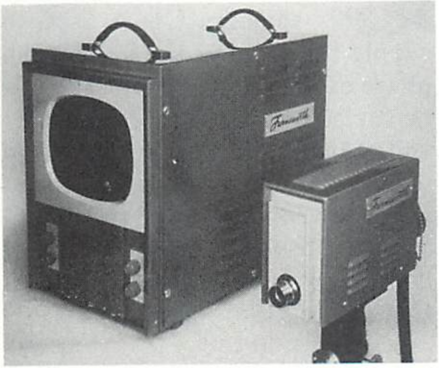


The industrial TV camera pictured here has the camera control unit self-contained. Only a monitor is required to complete the chain.
Courtesy Dage Television Division, Thompson Products, Inc.

The low voltage power supply of Figure 2 is conventional, and requires no further comment.

Installation and Adjustment

In operation, if the video signal to be fed to the monitor contains synchronizing information, the monitor sync selector switch S_2 is set to the video or internal position. If the signal does not contain synchronizing information, the switch is set to the sync or external position and a source of sync pulses is applied to one of the sync input jacks. The proper terminating resistance is required across the other sync input jack.



This camera chain is designed so that the control unit and monitor are combined with the camera being small and compact.
Courtesy Farnsworth Electronics Co.
Division of I. T. & T. Corp.

A video signal (preferably a test pattern) should be applied to the video input jack and power applied to the receiver. After two or three minutes warm-up time, turn the brightness control to its maximum clockwise position and adjust the ion trap magnet for maximum brightness. Reduce the brightness control to a point where the raster is just a little brighter than normal and adjust the focus control for best focus. Now readjust the ion trap magnet for the brightest raster.

Turn up the contrast control and adjust the horizontal and vertical hold controls, if necessary, to lock the picture into place.

Set the horizontal and vertical centering controls to the middle of their range and center the picture by adjusting the physical position of the focus coil. Minor centering adjustments can then be made with the centering controls. Never attempt to center the picture by adjusting the ion trap magnet.

The controls that vary the size of the raster horizontally and vertically are then adjusted for best results.

If it is necessary to adjust the horizontal oscillator, set the horizontal hold control to its maximum clockwise position and place a short across the horizontal phasing coil of Figure 2 (Terminals C and D of T_5).

Adjust the horizontal frequency slug until the picture falls into sync. Using a low capacitance probe, connect an oscilloscope to terminal C of the horizontal oscillator transformer T_5.

Remove the short from the phasing coil and adjust its slug to obtain the wave-form indicated at point C on the diagram. If the picture falls out of sync, readjust the horizontal frequency slug to bring it back into sync.

When the horizontal hold control is turned to its maximum counterclockwise position, the picture may fall out of sync but not more than three bars should appear. If more than three bars appear, repeat the above procedure.

TV RECEIVER CONNECTIONS

As previously mentioned, it may be desired to use regular TV receivers as monitors. In this case, it is necessary to feed the r-f signal modulated with the composite video signals to the antenna terminals of the receiver.

The input impedance of most receivers is 300 ohms and it usually is necessary to insert a matching pad between the coaxial cable feeding the receiver and the input terminals of the receiver. A suitable pad which consists of three carbon resistors is illustrated in Figure 3.

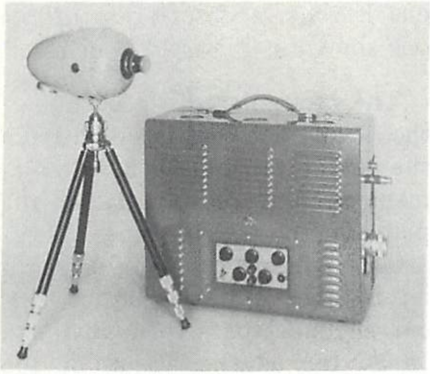
The receiver is then tuned to the same channel as the r-f oscillator in the camera or camera control unit.

REGULATED POWER SUPPLIES

In some of the more elaborate camera chains, **regulated power supplies** will quite often be found. These supplies prevent any change in the d-c output voltage due to variations in line voltage, load requirements or signal conditions. Even though the basic operation of voltage regulated power supplies has been explained in previous lessons, a description of the one shown in Figure 4 is given.

The unregulated d-c output of the 5U4G rectifiers is taken from the center tap of the 5 volt filament winding and applied to the plates of the 6AS7G tubes. These are the current carrying or regulator tubes and the entire B+ current must pass through them. In so far as the action of the tubes is concerned, the plates are all connected together and the grids are connected together as well as the cathodes. The 330 ohm resistors that are connected to each grid and the 150 ohm resistors that are connected to each plate provide isolation between the tubes. Such units prevent spurious oscillations from occurring; therefore, these resistors are called "parasitic suppressors".

The 50 ohm resistors, one of which is connected in the plate circuit of each 6AS7G, permit metering the current through each tube. When a current meter is plugged into J-1 and metering switch SW-3 is rotated, the current meter is placed in parallel with any one of the 50 ohm resistors in the plate circuits of the 6AS7G tubes. This permits quick metering of the plate current in each tube independently of the others. As a result, weak tubes can be readily spotted and replaced before they cause trouble.



This camera and control unit carries the idea of making the camera small and compact even further. Notice the relatively few controls on the control unit.

Courtesy General Precision Laboratories, Inc.

The combined plate current of all the tubes can be measured by setting the switch to the CURR position which places the meter in parallel with the 10 ohm resistor R-39.

The cathodes of the 6AS7G tubes are tied together and constitute the regulated d-c B+ output point which, in this power supply, is about 300 volts.

The 6SL7GT tube is a two stage control amplifier which amplifies any slight change in the regulated B+ output voltage. These changes are applied to the grids of the 6AS7G tubes and vary their conduction sufficiently to force the B+ to return to its original value.

Tubes V-10 and V-11 are connected in series to provide a constant voltage drop of 240 volts. The remainder of the regulated output, or 60 volts, is developed across R-30 and applied to the cathode of the right hand section of the 6SL7 tube. This places the cathode 60 volts positive and to prevent the tube from being cutoff, a positive voltage is applied to its grid by means of R-31. This voltage is made variable so that the regulated output voltage can be adjusted to any value within the limits of the circuit. Moving the arm of R-31 up increases the regulated output voltage and moving it down decreases the output voltage.

Since the grid of the left hand section of the 6SL7 is connected directly to the plate of the right hand section, it has a positive voltage applied to it. To counteract this direct voltage, the cathode is made more positive by the voltage drop across R-29. The voltage divider network of R-42, R-28 and R-29 is designed so that the voltage across R-29 is slightly larger than the direct voltage applied to pin #1 of the 6SL7 tube.

The overall action of the circuit is straightforward in that if the regulated output voltage tends to increase, this increase of voltage is developed across R-30 and applied to the cathode (pin #6) of the 6SL7. This increased bias reduces the 6SL7 plate current and causes the plate (pin #5) to become more positive. Being tied directly to the right hand plate, the left hand grid (pin #1) also becomes more positive and the plate current of the left hand section increases. This causes a greater voltage drop across R-24 and a resultant reduction in the plate voltage (pin #2).

Since the plate of the left hand section of the 6SL7 is tied directly to the grid of the 6AS7G tube(s) through the 330 ohm resistor(s), the reduced plate voltage is effectively an increase of bias on the 6AS7G tube(s) and causes an increase in the voltage drop across the 6AS7G tube(s). Since the 6AS7G tubes are in series with the regulated B+ output, an increased voltage drop across these tubes leaves less voltage for the regulated output and the regulated B+ output voltage reduces counteracting the original increase.

Of course, all of this action happens instantaneously and effectively prevents the regulated B+ output voltage from changing.

An additional point of interest in this circuit is the voltage divider across the regulated B+ output consisting of R-21 and R-22. The junction of these two resistors is connected to the filaments of the 6AS7G tubes and applies about 120 volts to them. Since the cathodes are at a direct voltage of 300 volts, this reduces the difference in potential between cathodes and filaments to about 180 volts and helps to prevent breakdowns between the elements.

LENSES

The lenses used with the camera are an absolutely necessary accessory as without them a meaningless "hodge-podge" of light distribution would occur on the vidicon photo-conductive layer.

Since it is the responsibility of the electronic technician to install and adjust the camera, he must be familiar with two basic characteristics of a lens: the focal length designated by the capital letter "F", and the rated speed or effective diameter designated by the small letter "f:".

The **focal length** (F) is the distance behind the optical center of the lens to the point where the parallel rays are focused. Thus, if an object at an infinite distance from the lens is focused 1″ behind the lens, the focal length (F) is said to be one inch. The greater the F (for a given lens diameter), the greater the physical length of the lens barrel.

The F of a lens determines the magnification of the image being viewed and the angle of field covered. As longer F lenses are used, the greater the magnification which provides a "close-up" to distant objects. Also, the longer the F of the lens being used, the smaller is the angle of coverage both vertically and horizontally.

Looking down from above, Figure 5 shows the horizontal coverage of two lenses with commonly used F sizes. Should it be necessary to mount the camera 80 feet from the object being viewed, and an object which is 13 feet wide is required to fill the screen, the 3 inch lens would be the proper choice. However, the height of the object being viewed must be considered which might change the choice of F size lens.

The camera and control unit shown in the previous picture are light enough that the young lady has no trouble carrying both units at the same time.

Courtesy General Precision Laboratories, Inc.

TV receivers, or monitors, are adjusted to reproduce pictures with a standard aspect ratio of four units in width to three units in height. Accordingly, the target of the vidicon upon which the lens focuses the image has an effective scanning area to suit this ratio, which is $\frac{1}{2}$ inch wide to $\frac{3}{8}$ inch high. Thus the vertical field is 0.75 times the horizontal field. Since the 3 inch F lens has a horizontal field of about 13 feet at a distance of 80 feet, the vertical field is 0.75 times 13 or about 10 feet. If the object to be reproduced is higher than 10 feet, the camera would either have to be moved away from it or a smaller F lens used to increase the field coverage.

The horizontal and vertical field covered by a given F lens is directly proportional to the active area of the surface upon which the image is being focused. The following ratios illustrate this relationship:

$$\frac{\text{F}}{\text{Scanned area width}} = \frac{\text{Distance of subject from lens (inches)}}{\text{Width of Field (Inches)}} \qquad (1)$$

The width of the scanned area is $\frac{1}{2}$ inch. Thus, to find the width of field covered by a 1-inch lens at a distance of 20 feet (240 inches), substitute the known values and let X equal the width of field as follows:

$$\frac{1}{0.5}=\frac{240}{X}$$

transposing the equation,

$$X=240\times 0.5 \text{ or } 120.$$

Therefore, X, or the width of field, is 120 inches or 10 feet which, in this case, is the horizontal field. The vertical field is 0.75 of 10 feet, or 7.5 feet.

To simplify the ratio and obtain the width of field directly in terms of feet, let:

F = focal length of lens (inches)
W = width of field (feet)
D = distance of subject from lens (feet)
A = width of scanned area (.5″ for vidicon)

Then the width of field can be determined from the following equation:

$$W=\frac{AD}{F} \qquad (2)$$

If it is desired to obtain the width of field of a 3″ lens at 30 feet:

$$W=\frac{0.5\times 30}{3}=\frac{15}{3}=5 \text{ feet.}$$

The vertical field then is 0.75×5 or 3.75 feet.

Chart 1 lists the horizontal and vertical fields for five lenses at every 10 feet up to a distance of 80 feet. If the distance from the object to the lens is fixed, the proper lens is easily selected. For example, if this distance is 60 feet, a $\frac{1}{2}$-inch lens will cover a field of 60×45 feet and 3 inch lens will cover a field 10×7.5 feet. "In

HORIZONTAL & VERTICAL FIELDS (IN FEET) FOR VIDICON CAMERA								
LENS	D = 10'		D = 20'		D = 30'		D = 40'	
F	W	H	W	H	W	H	W	H
1/2"	10	7.5	20	15	30	22.5	40	30
1"	5	3.75	10	7.5	15	11.2	20	15
2"	2.5	1.87	5	3.7	7.5	5.62	10	7.5
3"	1.6	1.25	3.3	2.5	5.0	3.75	6.6	5.0
6"	0.8	0.62	1.6	1.2	2.5	1.87	3.3	4.5
LENS	D = 50'		D = 60'		D = 70'		D = 80'	
F	W	H	W	H	W	H	W	H
1/2"	50	37.5	60	45	70	52.5	80	60
1"	25	18.7	30	22.5	35	26.2	40	30
2"	12	9	15	11.2	17.5	13.1	20	15
3"	8.3	6.2	10	7.5	11.6	8.75	13	10
6"	4.1	3.1	5.0	3.75	5.8	4.37	6.6	5

CHART 1

between" distances may be quickly estimated.

The horizontal angle of view of a lens used with the vidicon is approximately equal to:

$$\text{H angle} = \frac{27}{\text{F in inches}} \qquad (3)$$

The vertical angle is 0.75 of the horizontal angle. For comparison purposes, a table of vidicon lens angles is given in Chart 2.

LENS ANGLES FOR VIDICON CAMERA		
LENS	HORIZONTAL	VERTICAL
1/2"	54°	40.5°
1"	27°	20.25°
2"	13.5°	10.1°
3"	9°	6.75°
6"	4.5°	3.38°

CHART 2

The second important characteristic of the lens is the rated speed or f: number. A large diameter lens admits more light than a small diameter lens. The more the amount of light passed by a lens (greater the diameter), the higher is the rated speed.

The television camera lens has an adjustable iris, or diaphragm opening, which may be used to vary the effective diameter. The speed is rated at the widest "stop" opening, which gives maximum diameter. This iris has the same function as the iris in the human eye. The big difference is that the camera lens iris is not automatic and must be adjusted manually to the various lighting conditions encountered.

Lens speed is designated by the small "f:" and gets its rating from the following relationship:

$$\text{f:} = \frac{F}{d} \qquad (4)$$

where F=focal length and d=lens diameter with iris at widest opening.

If a lens with a focal length of one inch has an effective diameter of 0.66, the lens speed "f:" is 1.5. That is, $\text{f:} = \frac{1}{.66} = 1.5$. This is the speed of many ½-inch wide-angle and general purpose one-inch lenses. Many three-inch lenses have a "slower" speed of f: 2.5 which means that at maximum aperture, more light is required. In general, longer focal length lenses will have higher f: numbers.

Most lenses include two adjustments: (1) a focusing ring, which is adjusted in feet as shown on the ring calibration to obtain sharp focus at the designated distance, and (2) an iris adjustment ring which is calibrated in f: numbers. The iris is ordinarily opened to allow the most light such as f: 1.5 or f: 2.5 when a dim scene is being viewed. When a bright scene is being viewed, the iris is "stopped down". (Note that the higher the f: number, the smaller the opening.) The amount of light passed varies inversely as the square of the f: number ratios. If the opening is decreased from f: 2 to f: 4, the ratio is two and the amount of light is decreased by the square of two, or four. Thus one-fourth the amount of light is passed at f: 4 compared to that at f: 2.

Another effect of stopping down a lens, or increasing its f: number, is that the **depth of field** is increased. This is the portion of the scene that is in focus in the picture, whereas objects nearer or farther than these limits are out of focus. Factors increasing the depth of field are:

1. Shorter focal length lenses.
2. Smaller stop openings (larger f: numbers).
3. Greater distance between objects and camera for a given F lens.

The "Depth of Field Tables" which accompany most lenses can be used to obtain the approximate depth of field at various f: stops for different F lenses used.

To become familiar with depth of field characteristics, it is necessary to know the **hyperfocal distance** of a lens. The hyperfocal distance is that distance at which the nearest object is in focus when the lens is focused upon infinity. If the lens now is focused upon this hyperfocal distance, all objects from one-half the focused distance to infinity will be in focus. Thus, the shorter the hyperfocal distance of a lens, the greater the depth of field. Also, the shorter the focal length (F), the shorter the hyperfocal distance and the greater the depth of field.

The vidicon camera normally allows slightly greater depths of fields than those listed in the lens tables since the tables assume maximum diameter of the "circle of confusion" to be one-thousandth (1/1000) of an inch. (The "circle of confusion" is the spot on the vidicon target covered by the focused light rays.) In the TV system the maximum allowable diameter of the circle of confusion is two scanned lines or 1/700 of an inch.

To obtain the hyperfocal distance of a given F lens at a given f: stop,

$$H=\frac{(F)^2\times(1/dc)}{(f:)\times(12)} \qquad (5)$$

Where:

F = focal length in inches

1/dc = reciprocal of diameter of maximum allowable circle of confusion

f: = stop number

H = hyperfocal distance in feet

For example, find the hyperfocal distance of a one-inch F lens stopped at f: 1.5. Substituting in equation (5),

$$H=\frac{(1)^2\times\left(\dfrac{1}{\frac{1}{700}}\right)}{(1.5)\times(12)}=\frac{(1)^2\times\left(\dfrac{700}{1}\right)}{(1.5)\times(12)}$$

$$=\frac{700}{18}=39\text{ ft. (approx.)}$$

To find the depth of field of this same lens focused at 10 feet, the following equations may be used to find the limits of the depth of field.

$$\text{Near distance}=\frac{(H)\ (D)}{H+D}=\frac{(39)\times(10)}{39+10}$$

$$=\frac{390}{49}=8\text{ ft. (approx.)}$$

$$\text{Far distance}=\frac{(H)\ (D)}{H-D}=\frac{(39)\times(10)}{39-10}$$

$$=\frac{390}{29}=13.4\text{ ft. (approx.)}$$

Therefore, the depth of field is from 8 ft. to 13.4 feet, or 5.4 feet.

It has not been the object of this lesson to cover lenses thoroughly but merely to acquaint the electronics technician with some of their characteristics. If further information is desired, much good material can be found in most local libraries.

INSTALLATION PROCEDURE

Preliminary Checks

Due to the many variations in the equipment made by the manufacturers, the installation and adjustment procedures specified by the manufacturer should be carefully followed. However, the procedure outlined in this lesson can be used as a general guide in conjunction with the manufacturer's procedure.

Probably the first thing to determine is the distance the camera will be separated from the control unit. This is important because the filament voltage for the vidicon is quite often fed from the control unit, through the coaxial cable, to the camera. Since the voltage loss increases as the length of the cable increases, the filament voltage for the vidicon is usually varied by an adjustable resistance in the control unit so that it is exactly 6.3v a-c.

Before placing the camera in its permanent position, the proper length of cable can be used to connect it to the control unit (with all equipment in the same room) and adjust the vidicon filament voltage for exactly 6.3v a-c. Before turning the power on, however, be sure that the beam and target controls are turned to their minimum position which is usually in the maximum counterclockwise direction. This precaution will prevent any possible damage to the vidicon target while preliminary adjustments are being made.

The monitor should be given an operational check before any units are permanently installed as there is always the possibility of damage being incurred during shipment. Any additional monitors can be tested after the complete camera chain has been set up.

Camera Set-up

When unpacking the camera from its shipping crate, care should be taken so that the front, or lens end, of the camera is held higher than the back end. If the vidicon tube is shipped separately from the camera, it should always be handled with the target end up. These precautions are necessary to prevent any loose particles which might be inside the vidicon from striking the target and damaging it.

Most cameras are designed so that they will not function properly unless the camera control unit is connected to it. In many cases, the video signal output jack must be terminated with its proper load resistance. This requires that a terminating plug with the load resistance built in (usually 75 ohms) be connected to the video output jack.

After the equipment is connected, check all units to be certain the tubes are firmly seated in their sockets. Place a cap over the lens of the camera, adjust the target and beam controls to their maximum counterclockwise positions, apply power to the units and allow a warm up period of about 10 minutes.

The camera pictured here is set up to read the numbers on the passing freight cars. The information is cabled to a control location where it is recorded.

Courtesy Allen B. DuMont Laboratories, Inc.

If a vidicon filament control is used, adjust the control for 6.3v a-c while measuring the voltage directly at the filament connections of the vidicon.

Set the target control to about its mid-position and slowly rotate the beam control clockwise until the vidicon target appears on the monitor. Adjust the electrical focus for the best picture.

Monitor Raster Checks

Figure 6A shows the correct area that is to be scanned on the vidicon and the manner in which it will appear on the monitor. In order to distinguish between the raster of the monitor and the picture of the target being received from the camera, the monitor brightness control can be advanced and the contrast control turned down, making the monitor raster readily visible.

By increasing the contrast and gradually reducing the brightness, the camera raster or picture will be visible, smaller than and superimposed upon the monitor raster. If not, return the beam control to its original counterclockwise position, set the target control slightly more clockwise and repeat the procedure just described.

To avoid burning the target of the vidicon, operate the camera with the lowest setting (counterclockwise) of the target control which gives a good picture.

If the representation on the monitor appears with rounded corners or with edge flare, as shown in Figures 6B and 6C, the scanning beam of the vidicon is not properly centered. Should it be impossible to center the picture with the vidicon centering controls or, if the picture centers at the extreme setting of either control, the centering voltages should be checked. Assuming them to be normal, this off-center condition is probably due to one or both of the yoke windings being magnetized.

The easiest method of overcoming this residual magnetism is to charge a .1 μf capacitor to the B+ voltage and discharge it through the affected coil. If the picture is off center vertically, discharge the capacitor through the vertical winding of the camera deflection yoke while the camera is in operation and observe the resultant shift on the monitor. If the movement is in the wrong direction, recharge the capacitor and discharge it through the yoke winding with the polarity reversed. Repeat this procedure until the scanning is centered with the centering control in its mid position. Should the picture move too far, a smaller value capacitor can be used to obtain the desired results. The same procedure can be followed, if necessary, to center the picture horizontally.

There is also the possibility that the focus coil has been magnetized. This can be remedied by disconnecting the focus coil and connecting it across the output of a "variac" (with the variac line plug disconnected). Plug the variac into the a-c line and set it for 115 volts. Turn the variac on and reduce the voltage to zero. This reduction should be accomplished gradually in about five seconds. The power can be turned off and the focus coil reconnected.

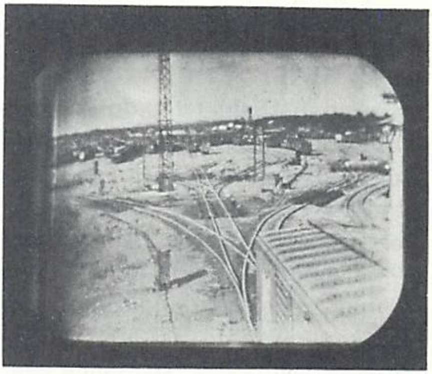
Vidicon Burn-in

The width, horizontal linearity, height and vertical linearity controls are present at the factory. However, it is important that these controls be set properly, that centering be accurate and that the vidicon be rotated to the correct position to prevent multiple raster burns.

When the vidicon is manufactured, it is put through a testing and aging process which results in a normal **burn-in** on the target. Even though the target is a circular electrode about one inch in diameter, the useful area is a rectangle of $\frac{1}{2}'' \times \frac{3}{8}''$ within this circular area. During the aging process, a conditioning of this useful area takes place which changes the sensitivity. Thus, the centering controls, the size controls, and the longitudinal position of the vidicon should be adjusted to use this aged area. It usually appears on the monitor screen as a lighter rectangle surrounded by dark edges.

If the raster is over-scanned, an area of different sensitivity will be noticed as shown in Figure 7A. If the raster is under-scanned, a smaller raster "burn" will be produced. This will result in reduced resolution of the picture obtained (fewer elements of the target being used) and, if full size scanning is later used, the smaller rectangular burn will be noticeable in the picture. This effect is shown in Figure 7B.

Improper centering will produce the effects as shown in Figure 7C and will be visible as a difference in picture brightness at one or two edges of the picture. In the case illustrated, the bottom and the right hand side would have a different brightness than the remainder of the raster or picture.



The railroad industry also uses the far seeing eye of the closed circuit system to keep track of the cars that are placed in the classification yard.

Courtesy Allen B. DuMont Laboratories, Inc.

Figure 7D shows the result of having the vidicon rotated so that the aged area of the target is not being fully used. Consequently, should it be necessary to install or replace the vidicon, it should be positioned and all controls should be set so that the same area of the target is being used as was previously scanned during the aging process.

Final Adjustments

A test pattern, or some other source of picture information, can be used to produce a picture. If the picture obtained on the monitor is unsteady or cannot be synchronized horizontally or vertically, the hold controls on the monitor and the camera should be adjusted. Most camera chains employ a master oscillator and frequency dividers to control the sweep circuits and continued lack of synchronization indicates trouble somewhere in the timer system. A slight adjustment of the master oscillator frequency control will usually cause the picture to lock in. If not, it will be necessary to completely check and possibly readjust each divider circuit.

With the aid of an oscilloscope, the output of each divider can be observed and adjusted. That is, with the timer switch set to the free-running position the first divider following the master oscillator can be adjusted. For example, if the first divider is a divide-by seven circuit, the divide-by seven control should be adjusted so that the tube fires on every seventh pulse. The remainder of the dividers should be adjusted similarly.

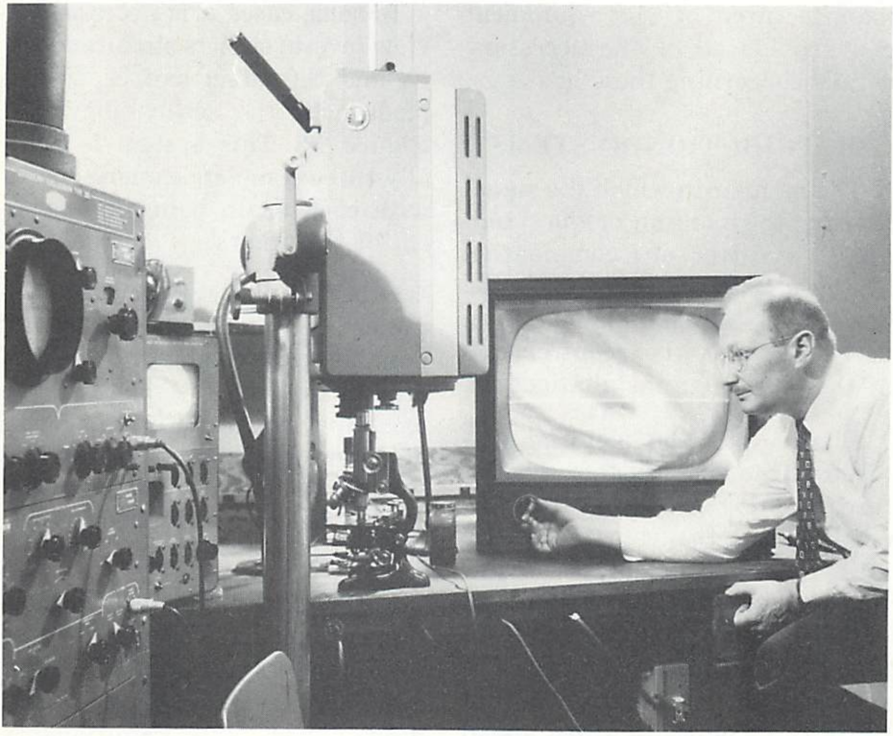
The master oscillator frequency control can then be adjusted so that a bar drifts slowly through the picture. Setting the timer-switch to the "timer in" position should cause the picture to be steady. If not, the trouble probably lies in the afc system of the timer and it will be necessary to investigate this circuit more thoroughly.

There is also the possibility that the difficulty may lie in the individual deflection circuits or in the sync circuits. However, no attempt is made here to cover all of the possible troubles in the camera chain. A thorough understanding of the equipment should provide the technician with sufficient information to enable him to locate and correct most of the troubles.

The final position of the camera will be determined by the size of the object being viewed, the size of the lens being used, lighting conditions and other circumstances peculiar to the installation. Two important "do nots" that should be observed when locating the camera are: (1) DO NOT have any direct light falling on the camera lens and, (2) DO NOT locate the camera where it will be subjected to excessive heat or vibration. Even though industrial cameras are designed for ruggedness, they are still delicate electronic instruments and must be treated with care.

Should it be necessary to install the camera where the temperature is higher than normal, an adequate cooling or ventilating system should be provided. In the event that the scene being viewed is the flame of a furnace or a similar bright object, a filter can be placed over the camera lens or the iris opening can be stopped down to reduce the amount of light entering the lens and striking the target.

When laying the cable, care should also be exercised so that it is not subjected to excessive temperatures, to prevent objects from striking it and to prevent any undue strain on the connection to the camera.



Research medicine finds the closed circuit TV system very useful. Here, the camera is being used in conjunction with a microscope to aid in the analysis of the substance being studied.

Courtesy Allen B. DuMont Laboratories, Inc.

If the camera is to be installed out of doors where it will be exposed to all types of weather conditions, a weatherproof housing can usually be obtained from the manufacturer. These housings include a windshield wiper, that can be remotely controlled, to permit operation of the camera even while it is raining.

Other special housings are also available which permit operation of the camera underwater and to protect it from explosions. The manufacturer of the equipment can provide all of the necessary details concerning these housings.

DISTRIBUTION SYSTEMS

The manner in which the signal is fed to the monitor, or the standard TV receiver, or a combination of these units depends upon the design of the equipment being used and upon the requirements of the particular installation.

Figure 8 is the pictorial diagram of the basic system. The interconnecting cable between the camera and the camera control unit is a multi-conductor cable that provides the camera with all of the necessary voltages and feeds video to the camera control. The output of the camera control unit feeds the composite video signal to the monitor.

Some manufacturers consolidate the camera and the camera control into one unit. In this case, the complete camera chain consists of the combination camera-control unit and a monitor. Figure 9 illustrates this system along with an extra monitor. When this arrangement is used, a modulated r-f output is usually available as well as the composite video signal. Figure 10 shows this latter system with the video being fed to a monitor and the modulated r-f being fed to a conventional TV receiver.

In some cases it is necessary to view several objects simultaneously, and the effect can be accomplished by the set-up shown in Figure 11. This system is actually three complete camera chains with each chain being independent of the others.

Other manufacturers make the camera as small and compact as possible while combining the camera control and the monitor into one unit. Shown in Figure 12, this distribution system also provides a modulated r-f output signal that can be fed to a standard TV receiver.

Some of the simpler distribution systems have been illustrated in Figures 8 through 12. However, a system can be devised to meet almost any requirements. Figure 13, for example, shows the method of connecting three cameras to as many TV receivers as desired and allows the personnel viewing each TV receiver to observe the picture produced by any of the cameras.

The output of the *combination* camera-control units is a modulated r-f signal. The frequency of Unit #1 is set to Channel 2, the frequency of Unit #2 is set to Channel 4, and Unit #3 is set to Channel 5. The three r-f signals are fed by coaxial cable to a mixing unit which mixes them linearly. Linear mixing is necessary to prevent the signals from modulating one another. As a result, the output of the mixing unit contains all three r-f signals and is fed to the antenna input terminals of the TV receivers.

Since the characteristic impedance of the coaxial cable is usually 72 ohms, a bridging transformer is connected between the TV receivers. This transformer matches the 72 ohm impedance of the cable to the 300 ohm impedance of the receiver. It also provides a 72 output connection which is used to feed the next TV receiver. Finally, an impedance matching transformer is used to feed the last TV receiver in the string.

In this way, each TV receiver can reproduce the output of any of the cameras merely by tuning the receiver to the channel desired. Also, the receivers are completely independent of each other and all of them can be turned to reproduce the output of the same camera or different cameras as desired.

Figure 14 is basically the same as Figure 13, the only difference being that the cameras and the camera control units are separate from each other rather than being combined as in Figure 13. In a commercial set-up, the three camera control units, the r-f mixer and one TV receiver would all be centrally located so that each camera could be controlled by one operator, if necessary.

The distribution system of Figure 15 has the composite video signal from the three camera controls being fed into a video switcher. This is merely a device which permits the operator to select the output of any one of the cameras and feed it to the monitors. Remote monitors can be added to the system and each of them will reproduce the same picture.

SERVICING

Industrial camera equipment should not give as much trouble as electronic devices that are sold to the general public. Since the cost of the equipment is not the most important factor, the manufacturer can design the equipment so that none of the component parts are overworked. Also, he can use high quality parts and take the time to pretest all equipment before it leaves the factory.

One of the most important duties of the service technician is to maintain the equipment in good working condition and make periodic checks to prevent trouble from occurring as breakdowns often cause costly losses to the organization using the equipment.

One of the most effective ways to prevent breakdowns is to keep an accurate log of the hours of operation of each piece of equipment. Record all tube changes as frequent failure of any tube or tubes may be an indication that a component used in the particular circuit is defective and causing the tube failures. The unit in question can then be thoroughly checked at the earliest convenient time.

Also, the average dependable life of most tubes has been ascertained by the manufacturer and many organizations replace all tubes that have been in operation for this specified length of time even though the tubes are not causing any trouble. An alternative method is to periodically test all tubes with a mutual conductance type tube checker and replace all those that do not come up to specifications.

Regular examinations of all interconnecting cables should be made with special attention given to all points where connections are made. The cable should be run through piping, or protected by some means, at places where it is subjected to more than normal abuse.

A small vacuum cleaner should also be a part of the serviceman's equipment and it should be used as often as necessary to prevent an excessive amount of dust and dirt from accumulating on the equipment. A soft, lint-free cloth and special cleaning fluid should be used to clean the camera lenses as they can be permanently injured by careless or improper handling.

Included in the equipment may be motors for remote control of panning, tilting, and focusing the camera. If so, these should be cleaned and oiled regularly and any gears used in conjunction with the motors should be cleaned and given a light coat of the specified grease.

In spite of these preventive measures, failures will still occur and the technician must be capable of locating and correcting the difficulty as quickly as possible. To do this, a thorough understanding of the equipment is essential and it is worth while for the technician to spend sufficient time studying available information to enable him to work efficiently and quickly.

Accompanying most equipment of this type are resistance, voltage, and peak-to-peak wave-form charts. If these are not provided, the technician should prepare them at a time when the equipment can be shut down and these tests can be made. Information of this type is extremely valuable when attempting to locate and correct defects.

The test equipment required by the serviceman is essentially the same as that required by a regular TV serviceman. Typical is that of a voltmeter that has a sensitivity of at least 20,000 ohms per volt, or a vacuum tube voltmeter; an ohmmeter that is capable of measuring at least 100 megohms; a mutual conductance type tube tester; an oscilloscope with the vertical sensitivity being .05 volts rms per inch or better and the frequency response being 2.5 mc or better and an audio or video frequency generator.

The trouble shooting procedures for closed circuit TV equipment are no different than for regular television receivers and no attempt will be made here to give step-by-step methods. The most important consideration in the servicing and maintenance of any electronic device is to thoroughly understand how it operates.

Since color television is rapidly developing into an important part of the television industry, the next lesson takes up the subject of color so that this information can be used advantageously in the lessons on color television that follow.

* * *

ESSENTIAL SYMBOLS AND EQUATIONS

F = Focal length of lens.

f: = Rated speed or effective diameter of lens.

W = Width of field (feet).

D = Distance of subject from lens.

A = Width of scanned area (½″ for vidicon).

d = Lens diameter with iris completely open.

H = Hyperfocal distance of a lens.

1/dc = Reciprocal of diameter of maximum allowable circle of confusion.

$$\frac{F}{A}=\frac{D}{W} \qquad (1)$$

$$W=\frac{AD}{F} \qquad (2)$$

$$H\ \text{angle}=\frac{27}{F\ \text{in inches}} \qquad (3)$$

$$f{:}=\frac{F}{d} \qquad (4)$$

$$H=\frac{(F)^2\times(1/dc)}{(f{:})\times(12)} \qquad (5)$$

IMPORTANT DEFINITIONS

BURN-IN—An area on the target of the camera tube which has a different sensitivity than other areas. The center portion of the target usually has a normal "burn-in" condition due to the aging process. The burn-in area appears lighter than the remaining area.

DEPTH OF FIELD—The distance from the nearest object in focus to the farthest object in focus.

FOCAL LENGTH—The distance from the optical center of a lens to a point behind the lens where parallel rays of light are focused.

HYPERFOCAL DISTANCE—The distance from the optical center of the lens to the nearest object which is in focus when the lens is focused on infinity.

IRIS—The opening in front of the lens which varies its effective diameter and the amount of light that can enter the lens. The iris of lenses used with TV cameras are practically always adjustable.

MONITOR—A piece of equipment containing the necessary components to produce a picture on a kinescope when the video signal and the sync pulses are available.

REGULATED POWER SUPPLY—A power supply in which the direct voltage output is maintained at a pre-determined value by electronic control circuits even though the alternating voltage of the line or the load current varies within certain limits.

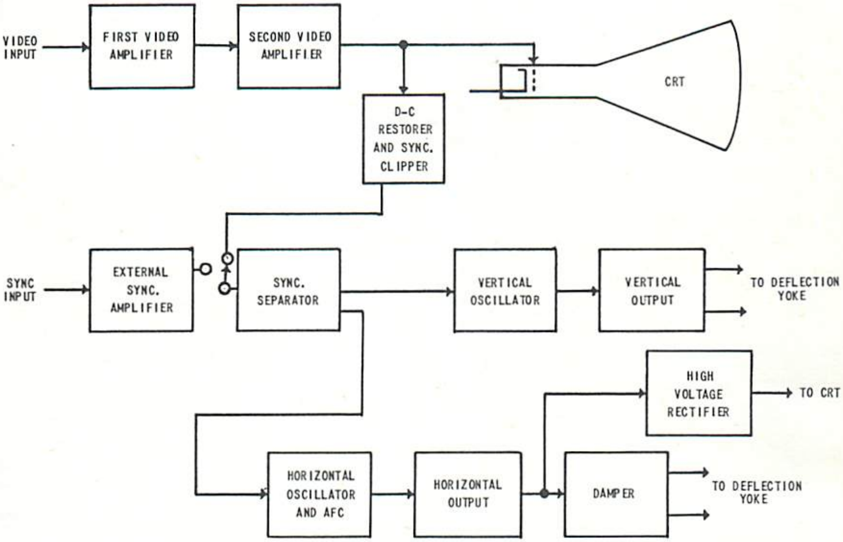


FIGURE 1

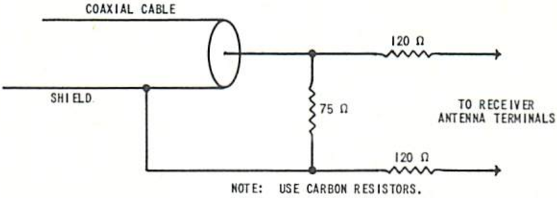


FIGURE 3

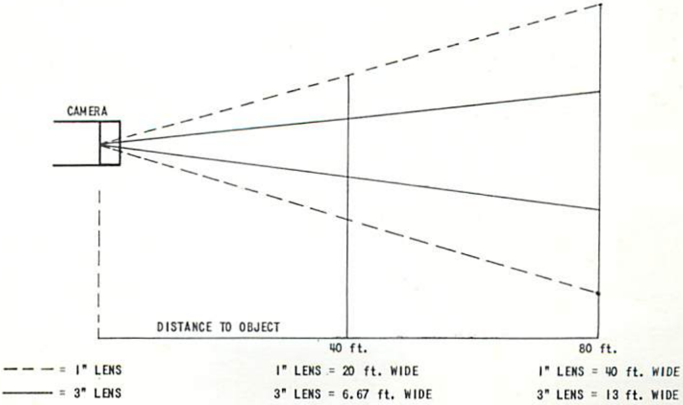
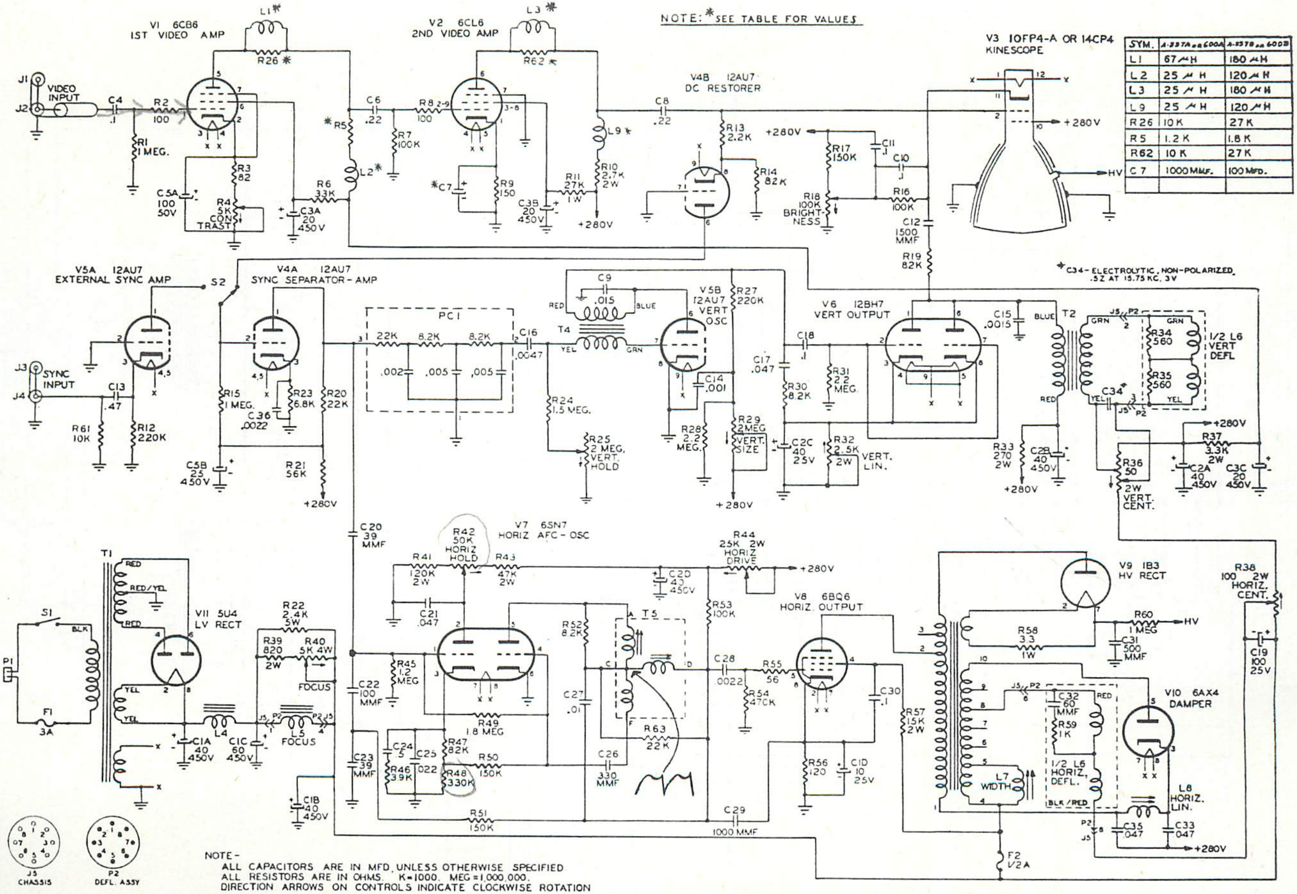


FIGURE 5



SYM.	A-337A or 600A	A-337B or 600B
L1	67 μH	180 μH
L2	25 μ H	120 μ H
L3	25 μ H	180 μ H
L9	25 μ H	120 μ H
R26	10 K	27 K
R5	1.2 K	1.8 K
R62	10 K	27 K
C7	1000 MMF.	100 MFD.

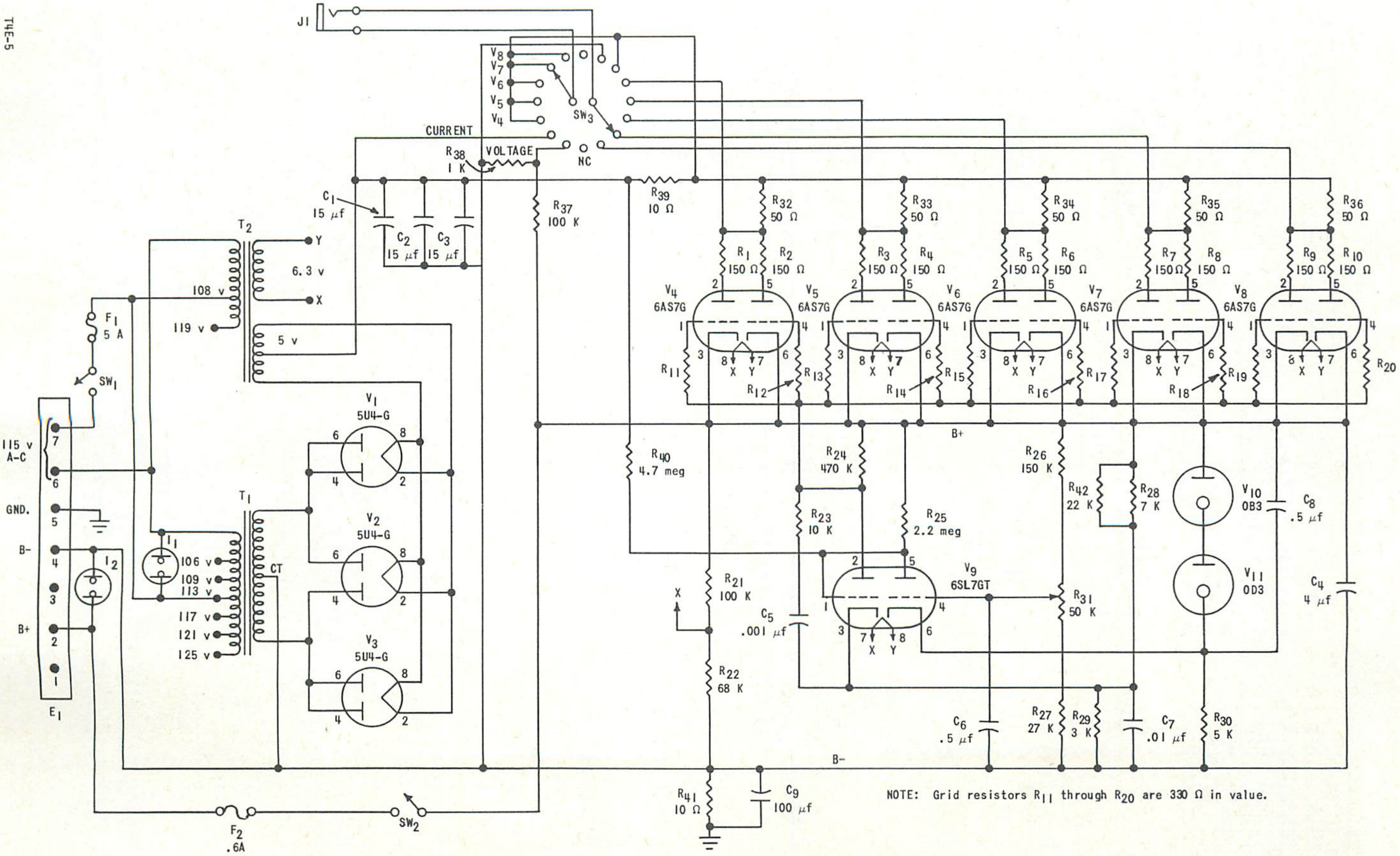
NOTE -
ALL CAPACITORS ARE IN MFD, UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS. K=1000. MEG=1,000,000.
DIRECTION ARROWS ON CONTROLS INDICATE CLOCKWISE ROTATION

T4E-5

COURTESY DAGE TELEVISION, DIV. OF THOMPSON PRODUCTS

FIGURE 2

T4E-5



NOTE: Grid resistors R_{11} through R_{20} are 330 Ω in value.

FIGURE 4

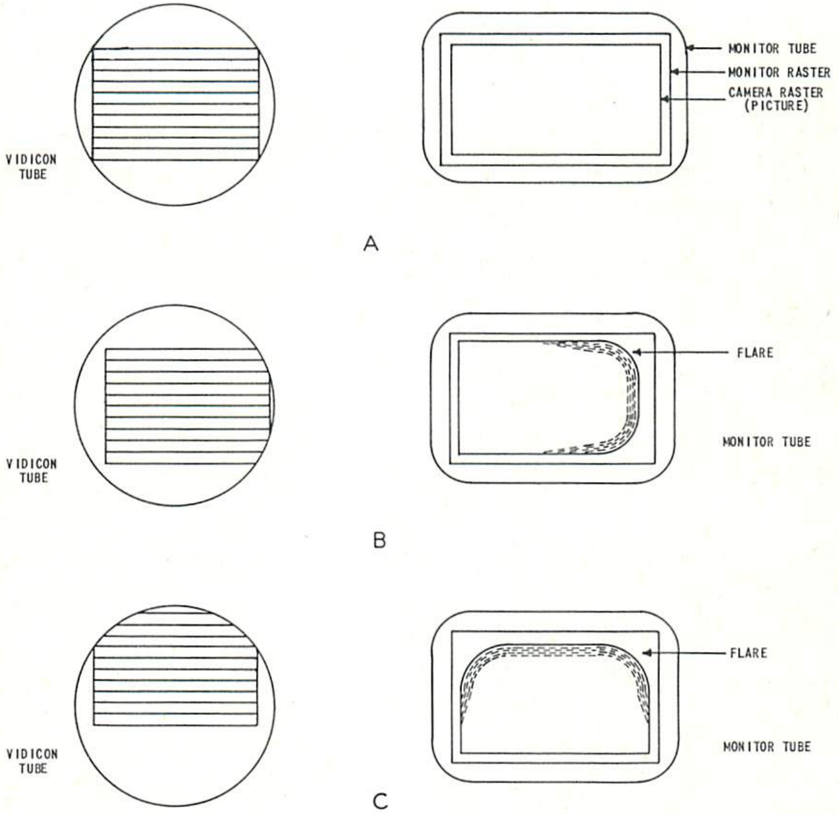


FIGURE 6

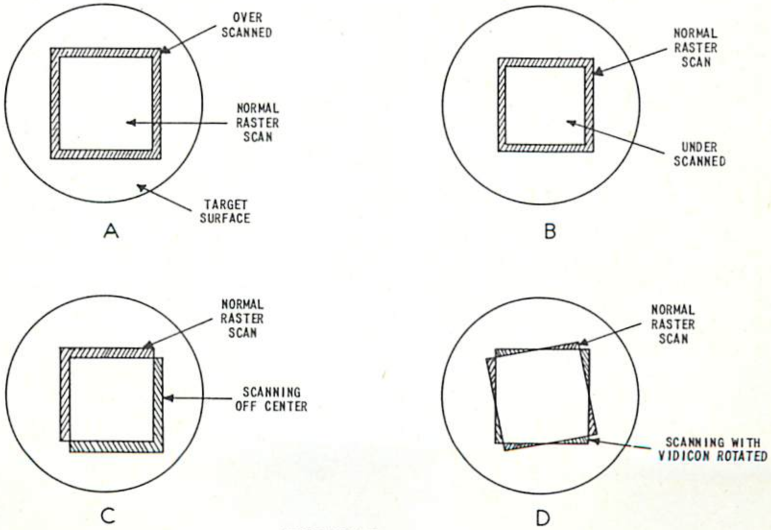


FIGURE 7

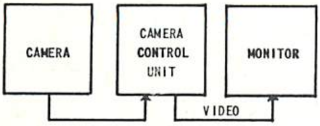


FIGURE 8

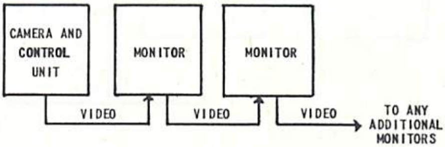


FIGURE 9

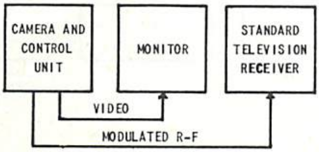


FIGURE 10

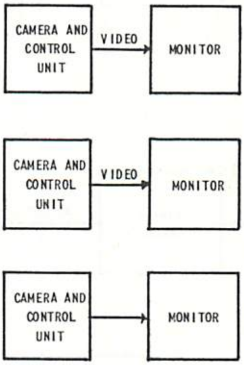


FIGURE 11

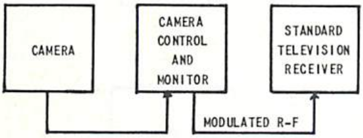


FIGURE 12

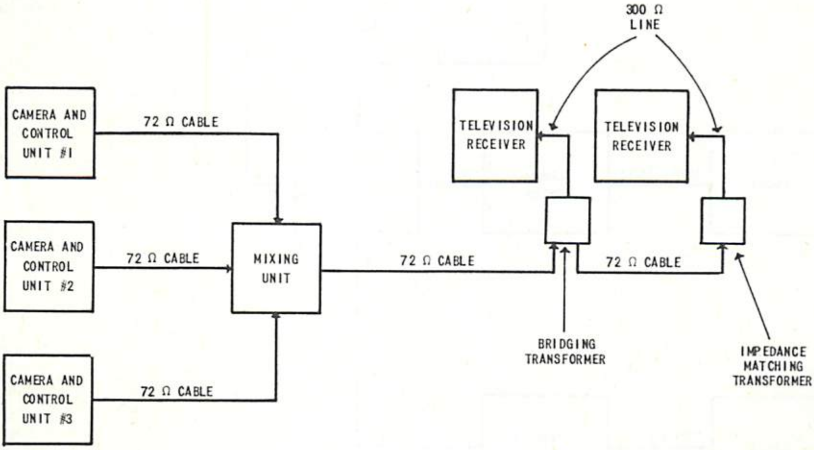


FIGURE 13

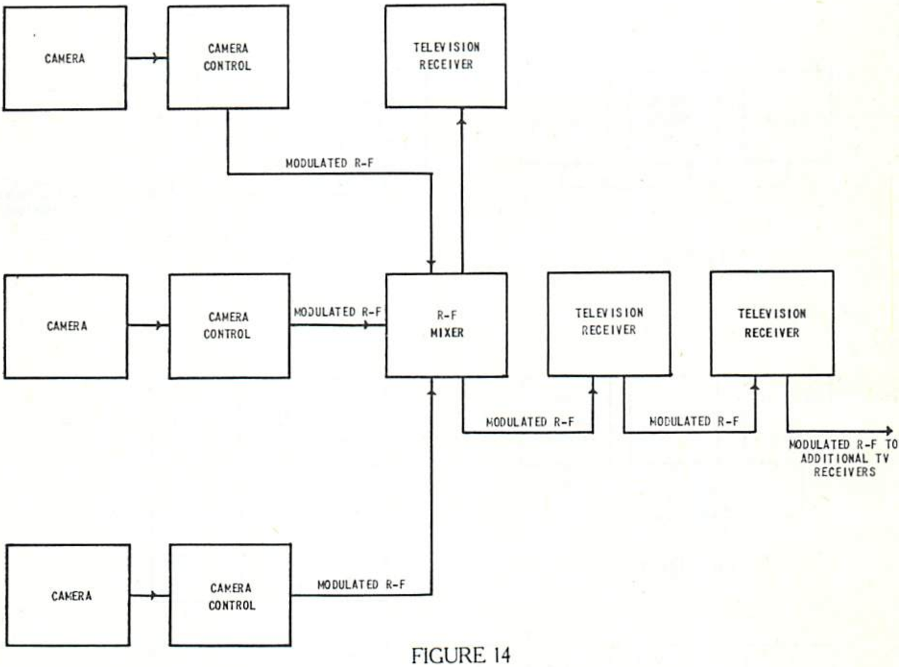


FIGURE 14

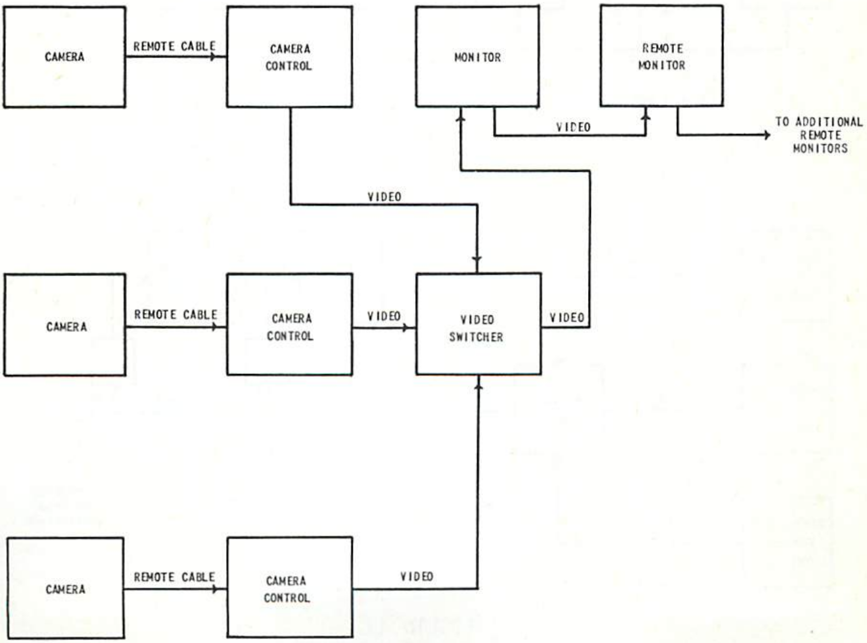


FIGURE 15

FROM OUR *Director's* NOTEBOOK

"Putting SELL-O into Your Hello"

If you're planning a TV-Radio business of your own, the telephone can be a most important asset—IF YOU USE IT PROPERLY.

A good telephone personality is a decided advantage to a businessman. Often, first impressions with your customers are made by phone and good impressions mean a great deal of future business for you.

When you talk on the phone, your VOICE has to represent your entire personality. The person at the other end can't see your EYES, your SMILE, your GESTURES or any of these other "three dimensional" personality traits. Your voice alone does the selling.

How can you put that SELL-O into your hello? Well, you can start by being courteous. Improve your phone manners by speaking directly into the transmitter and slowing down your speech about one-third. Other helps: pitch your voice in the middle register, spell out proper names, repeat figures, instructions.

Adopt a persuasive phone attitude. Pick the right words and "say it with flowers" in your voice.

Yours for success,

W. C. DeVry

DIRECTOR

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